THURSDAY, JUNE 29, 1893.

ELECTRO DYNAMICS.

Dynamo Electric Machinery. Fourth Edition. Revised and enlarged. By Silvanus P. Thompson. (London: E. and F. N. Spon, 1892.)

A COMPARISON of the size of the fourth edition of this book with that of the first, which appeared in 1884, supplies a good illustration of the rate at which the use of dynamo electric machinery, and our knowledge of its laws, have advanced during the past eight years. The 408 pages in 1884 have grown to 832, with a collection of twenty-nine excellent plates in addition at the end of the book, representing another 60 pages; in fact, the book has now become so portly that it would have been well had the matter been put into two volumes.

Each of the last three editions has been bulkier than its predecessor, but the increase of size of the second and third represented the simple adding of new material without the pruning away of antique and practically obselete matter which is so necessary in a textbook of a rapidly advancing industry. The last edition, on the contrary, has been rewritten, and the author's well-known capacity for hard work and information collecting has enabled him to produce a treatise which contains the latest knowledge and the existing practice of the dynamo designer and the dynamo constructor of to-day.

The book opens with a wonderfully complete collection of historical notes, but we fear that the author's love of history has led him to give a little too much credit to the early workers. It is the fashion with some, and especially with those of classical tendencies, to credit the Chinese with the invention of gunpowder, the compass, and a variety of other useful commodities; to condemn Galileo, Columbus, and Harvey as plagiarists; and to extol Pliny or Aristotle, or other gentlemen of that somewhat remote period, as having foreseen and foretold every scientific principle and device.

But as these prophecies of the ancients were somewhat marred by their utter unsuggestiveness until the discoveries of the moderns had set the historian searching for a meaning which the writers of the prophecies were themselves probably quite ignorant of, we do not regard the trousered investigator as a dealer in second-hand articles.

Nobody knows better than Dr. Thompson that a knowledge of the properties of rubbed amber, or the discovery of the loadstone, was not all that was necessary to construct a 1000 horse-power dynamo with a commercial efficiency of 93 per cent., but nevertheless he fails, we think, to sufficiently distinguish between a chance mention of some notion and the subsequent independent recognition of an important commercial principle. If fame could really be achieved by a person's mingling a grain of wheat with a ton of chaff, what a temptation it would be to spend one's time recording every notion that struck one (no matter how improbable it looked), in the hopes that a hundred years hence some indulgent historian would search through the weary waste, in the hope of discovering with his rosy spectacles an apparent anticipation of some device that practice had then brought to a successful issue.

The historical notes are in fact not critical enough, and show a desire to make things comfortable all round for everybody. For example, the conventional illustration of the Pacinotti machine is given, but the author does not point out, indeed we do not remember to have seen it pointed out, that the original illustration of the Pacinotti generator differed from the conventional illustration in that the collecting-brushes were placed in the worst position, so as to make the machine as powerless as possible. May this have been the real reason why this machine "fell into temporary oblivion"?

If another example were wanted, we might take the following sentence, which, although not occurring in the section called "Historical Notes," enters as a note of an historical character on page 59, in the section, "Combinations to give Constant Pressure." The sentence is, "The combination of a permanent magnet with electromagnets in one and the same machine is much older than the suggestions of either Deprez or Perry, having been described by Hjorth in 1854." Undoubtedly that is true, only Hjorth used the combination because, not being aware of the instability of the magnetism in a properly designed dynamo, he thought permanent magnetism was necessary to start the magnetic excitation; whereas Deprez and Perry superimposed what was practically a permanent field for a totally different reason and in a totally different way.

The chapters on "Magnetic Principles," the "Magnetic Circuit," "Forms of Field Magnets," are excellent. We do not, however, see much advantage in the introduction of what the author calls the *diacritical* current. The formulæ are thereby simplified, no doubt, but the simplification is effected at the sacrifice of accuracy; for first, the permanent magnetism in the field has to be ignored, and secondly, as there is no absolute maximum induction in iron, there can be no exact value of this *diacritical* current, which produces half the maximum induction.

The author is not quite happy in his choice of symbols. E is defined as representing the entire electro-motive force in the armature, e as the difference of potentials from terminal to terminal. Presumably, then, e_1, e_2, &c., applied to the separate coils of the armature, represent the potential differences at the terminals of the several coils. But that is exactly what e_1, e_2 do not mean, for they stand for the electro-motive forces of the coils. The suffix m attached to the letter for current or resistance denotes field magnet coils, but only when these are series coils. If the coils be shunt coils, the suffix s is attached to the letter. S, however, stands not for the number of shunt coils, as one would expect, but for the number of series coils, the former being called by a different letter altogether, viz., Z. In fact, Dr. Thompson's rules for the use of suffixes have the precision that is possessed by the rules for the spelling of the English language, the delight of every foreigner who studies them.

The description of "Combinations to give Constant Pressure" (pages 57, &c.), and of "Constant Potential Dynamos" (pages 277, &c.), might be well brought together, seeing that both parts of the book deal with the same contrivances, only a little mathematics is added when the subject is taken up the second time. The equations that are given were very useful in the early days when the combinations were first worked out, as they showed what combinations were theoretically possible to produce the desired result. But it is questionable whether these equations are of much use at the present time, or if they are given, it should be clearly explained why equations originally obtained on the assumption that the permeability of iron was constant led to conclusions distinctly valuable in the case of machines intended to produce constant pressure, but quite useless for suggesting a method of compounding a dynamo to produce constant current.

The chapter on lap, wave, and ring winding of armatures is most instructive. The original idea of cross connecting the coils of a gramme ring, so as to only require two brushes with a multipolar dynamo, the author attributes to Mr. Mordey, but we were always of opinion that Prof. Perry's patent of 1880 contained the first suggestion of this now well-known arrangement.

Chapters xiii., xiv., xv., xvi., xvii., and xviii., on "Practical Construction of Armatures," "Commutators, Brushes, and Brush Holders," "Mechanical Points in Design and Construction," "Elements of Dynamo Design," "Arc Lighting Dynamos," and "Examples of Modern Dynamos," taken in conjunction with the twenty-nine plates at the end of the book, contain a wonderfully compressed, and most admirable, *résumé* of British and foreign practice, and make one feel proud that they have been written by an Englishman.

In Chapter xx., on electromotors, the laws of maximum activity and maximum efficiency are carefully distinguished, and it is pointed out that, while Jacobi, Verdet, Müller, and even Weidemann stumbled, the true ideas of Thomson and Joule were put forth correctly by Achard in January 1879. In 1883 was advocated the proposal to employ a forward lead of the brushes with a motor, and a backward lead with a dynamo, so that the magnetisation of the armature might help instead of opposing that of the fields magnets. With reference to this idea the author says, "The fascinating notion of using the armature to magnetise has proved a failure in practice," a statement undoubtedly true historically, but lacking in prophetic inspiration, seeing that this proposal of May 1883, to utilise instead of counterbalancing the magnetism of the armature is now warmly welcomed in May 1893, after Mr. Sayers has shown how the "destructive sparking" can be annihilated.

Chapter xxii., on "The Principles of Alternate Currents," is much too meagre for any one who does not already know more of the subject than is contained in the chapter itself. A student reading the book would be inclined either to skip this chapter altogether and go on to the next, on "Alternators," or turn to some other book for what Chapter xxii. professes to give. The account of the construction of alternating current dynamos contained in Chapter xxiii. is as comprehensive as the description of the principles in the preceding chapter is meagre. The abstract of Dr. J. Hopkinson's investigation on the coupling of alternators is clearly given and easily understood, when the misprint of N A for N H on page 691 is corrected. The device of commutating the current round the field of an alternate current motor, so that when the motor synchronises the excitation is produced by a pulsating direct current, is due originally to Prof. Forbes, and not to Mr. Mordey, as the author states on page 702.

The author is very perplexing in his naming of alternating currents. He calls the current produced by an ordinary alternator a *two phase* current, but why we have no idea. At any one moment the current in all parts of the circuit is in *one phase;* at different times the current has, of course, every possible phase in succession. The current must therefore be called a *one phase* current, or a single current having every possible phase in succession, if the author prefers that; but there is no more reason to call such a current a *two phase* current than to call it a twenty-two phase current. When again we come to the arrangement devised by Ferraris, and illustrated in Fig. 455 (page 405), we have two distinct circuits, the currents in which always differ in phase. We have therefore a two phase arrangement. The author however calls this a "*four phase transmission.*" Lastly, however, when there are three circuits in which there are three distinct currents, the phases of which at any one moment are always all three different, the author, for some reason, is content to call this a "three phase current" like ordinary mortals.

Chapter xxv., on alternate and direct current transformers, is good, but might be made a little fuller, seeing that so very much work has been carried out on transformers during the past few years. The methods of testing transformers are becoming as important as those for "Testing Dynamos and Motors," which forms the subject of Chapter xxviii. The last chapter, on the "Management of Dynamos," contains many valuable hints, derived in some cases from the author's own experience.

The table at the end of the book, headed "Wire Gauge and Amperage Table," we have gazed at with feelings of admiration tempered with doubt. Admiration—because, if all the columns of numbers given in this table be correct, then, while we have spent much time experimenting and calculating in order to obtain information about the heating of one or two bobbins of wire traversed by a current, the problem for bobbins wound with all kinds of wire to all sorts of depths up to 4½ inches has in some way or other been solved. Doubt—because we fear that, in solving this problem, some sort of simple proportion may have taken the place of the complicated mathematics which it is necessary to employ on account of the flow of heat taking place across many layers of copper and cotton interspersed.

To say that this book is the best on its subject in the English language is to say too little, since we know of no book in any other language on the same subject that can be compared with it. The few peculiarities that we have drawn attention to must be regarded less in the light of blemishes than as giving the book individuality, for we recognise our best friends, when we meet them, by their characteristic peculiarities. Dr. Thompson's treatise should be, nay, probably is already, in the hands of every one who deals with dynamo machinery from an educational or from a manufacturing point of view.

It is interesting to notice how the author, in common with other writers, is unconsciously searching for a good abbreviation for the important, but somewhat cumbersom expression—difference of potentials. Sometimes he calls it pressure, but he apologises for that, as he says it is popular. Sometimes he calls it potential, which we think is rather the expression to be apologised for, since it is wrong, the potential of a body having years ago been defined as being the difference between its potential and that of the earth. Sometimes he calls it the volts, but to speak of the volts of a dynamo being too high is like telling your tailor that a coat has too many inches when you mean it is too long. Voltage again appears to us as bad as amperage, a name which, by the bye, enters into the heading of the last table in the book. If we talk of the amperage instead of the value of the current in amperes, why not speak of the microfaradage of a condenser instead of its capacity in microfarads, or of the feetage of a tall man as being 6½? The names current, resistance, capacity, &c., require a short analogous name for difference of potential. Years ago Mr. Latimer Clark suggested that the name *potency* was going a-begging. How would this do as short for potential difference if the industrial name, pressure, be objected to? But, the shortest abbreviation of all is the initials of the words potential difference and our own, P. D.

CAPTAIN COOK'S JOURNAL.

Captain Cook's Journal during his First Voyage round the World, made in H.M. Bark "Endeavour," 1768–1781. A literal transcription of the original MSS., with notes and introduction. Edited by Captain W. J. L. Wharton, R.N., F.R.S., Hydrographer of the Admiralty. Illustrated by maps and facsimiles. (London: Elliot Stock, 62, Paternoster Row, 1893.)

CAPTAIN WHARTON has rendered excellent service to naval and colonial history, and to geographical science, by editing a transcript of Captain Cook's journal of the voyage of the *Endeavour*, which was undertaken chiefly for the purpose of observing the transit of Venus across the sun's disk, and which led to the founding of the Australian Colonies by Great Britain As is well known, the published accounts of that voyage are two, and neither of them satisfactory. The only very complete one is that compiled by Dr. Hawkesworth, from the journals of Cook, and of Mr. (afterwards Sir Joseph) Banks, who accompanied the great navigator as a volunteer, taking with him an eminent scientific man, Dr. Solander, a pupil of Linné, two artists, and servants, all of his own providing. The other is a brief and defective journal kept by Mr. Parkinson, one of Banks's artists, who died before the expedition reached England. It contains rude illustrations of the scenery and peoples of the Pacific Islands, which, if faithful reproductions of the originals (which I doubt), would show that his artistic powers were contemptible. Parkinson's narrative, which was edited by his brother, was published surreptitiously. It was suppressed by authority, and is, happily, not frequently met with.

Dr. Hawkesworth, on the other hand, has been severely and justly censured for the method he adopted, namely, the fusion of the journals of Cook and Banks,[1] and for attributing to their authors inept reflections of his own, an operation for which, even had it been advisable, he had not the ability, from his obvious want of appreciation of the distinctive labours of the navigator and of the naturalist.[2] The result is a narrative in which the performances of the actors are inextricably confounded, and the records of Cook, and doubtless also of Banks, in some cases garbled. With regard to the reflections, they are comparatively of small account, and there is little difficulty in recognising and rejecting them; they were in keeping with much of the literary style of the age, and Dr. Hawkesworth assures the reader that his whole work was before publication submitted to and approved by the members of the expedition then in England.

Unsatisfactory as Hawkesworth's account of the voyage is, it has the inestimable advantage of in some measure filling what would otherwise be a lamentable void in the annals of science, for strange as it must appear, not even a meagre life of Banks has ever been written, and but for Hawkesworth's work and "Cook's Journal," there is no published account of his indefatigable labours during the expedition. Banks, no doubt aided by Solander, kept a full journal of many events that happened during the voyage, which the commander had not the opportunity of witnessing or recording; and the admirable observations on the physical features, populations, languages, economic products, manufactures, zoology, and botany, of the islands, and coasts visited, are presumably for the most part his. Cook, indeed, especially mentions the signal services which Banks rendered, especially in the management of the natives, in acquiring their languages, in provisioning the ships, and in collecting information and objects of interest; and it needs no reading between the lines of his concise narrative to prove his appreciation of his companion, who he invariably took with him wherever he landed.

The materials for the reproduction of the journal of which Captain Wharton has availed himself with great judgment, are a complete copy of "Cook's Journal" in the possession of the Admiralty; another belonging to the Queen, that was transmitted to England from Batavia, thus containing everything of importance; and thirdly, a duplicate of this last, which having been appropriated by the Secretary of the Admiralty, Sir Philip Stephens, passed to his descendants, and from them by sale first to Mr. Cosens in 1868, and in 1890 to Mr. John Corner. The latter gentleman was arranging for the publication of his copy, with the view of devoting the proceeds to the restoration of Hinderwell Church, the parish church of Staithes, whence Cook ran away to sea, when he suddenly died, and the carrying out of his project devolved upon his son, who completed the arrangements which led to Captain Wharton's under-

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[1] Sometimes alluded to as the journals of Mr. Banks and of Dr. Solander, though there is no reason to suppose that the latter individual kept any journal independently of that of Banks, of whom he was probably the amanuensis, as Mr. Orton (the ship's clerk) was of Cook.

[2] A conspicuous example of this is Hawkesworth's omission of the passage in Cook's journal (Wharton, p. 322) dwelling on the unaccountable absence of the cocoa-nut (except of its shells cast upon the beach) on the east coast of Australia, which is a most remarkable feature in the geographical distribution of that plant. A few living specimens exist at Rockhampton and Keppel Bay, but in an unhealthy state, producing no fruit, and probably introduced by Europeans.